Problem on Rigid type flange Coupling:

1. Design a C.I protective flange Coupling to connect two Shafts in order to transmit 7.5 kw at 720 rpm. The following permissible Stresses may be used.
   permissible shear stress for shaft, bolt & key = 33 Mpa.
   permissible Crushing stress for bolt & key = 60 Mpa.
   Permissible shear stress for C.I Coupling = 15 Mpa.

Given:

Power $P = 7.5\,kW$.

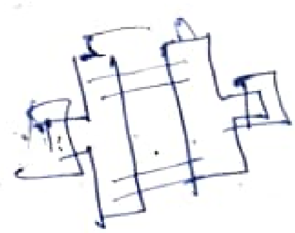
Speed $N = 720\,rpm$.

permissible Shear for Shaft, bolt & key = 33 Mpa

" Crushing for bolt & key = 60 Mpa

" Shear for C.I Coupling = 15 Mpa.

Design for Hub:



We know,

$$P = \frac{2\pi N T}{60}$$

$$\text{Torque } T = \frac{7.5\times10^3\times60}{2\times\pi\times720}$$

$$\boxed{T = 99.47\times10^3\ N\cdot mm}$$

To find ϕ of Shaft:

$$T = \frac{\pi}{16}\times\tau_s\times d^3$$

$$d^3 = \frac{99.47 \times 10^3 \times 16}{33\pi}$$

$d = 24.5$ mm $\simeq$ $\boxed{d = 25mm.}$

Design of muff

∴ Inner ϕ of hub $d = 25$ mm.

Outer ϕ of hub $D = 2d = 50$mm.

Length of hub $L = 1.5d = 37.5$ mm.

Checking for shear stress in Hub:

$$T = \frac{\pi}{16} \times \tau_c \times \left[\frac{D^4 - d^4}{D}\right]$$

$$99.47 \times 10^3 = \frac{\pi}{16} \times \tau_c \times \left[\frac{50^4 - 25^4}{50}\right]$$

$\boxed{\tau_c = 4.32 \text{ Mpa}}$ < 15Mpa given, ∴ Safe.

Design of key:

For ϕ25mm Shaft, Take $W = 10$ & $t = 8$. an

Length of key $= 1.5d$ = Length of hub = 37.5mm.

Checking for Shear in key:

$$T = l \times w \times \tau_k \times d/2.$$

$$99.47 \times 10^3 = 37.5 \times 10 \times \tau_k \times 25/2.$$

$\boxed{\tau_k = 21.22\ Mpa}$ < 33 Mpa given, The design is safe

Checking for Crushing Stress:

$$T = l \times t/2 \times \sigma_{ck} \times d/2.$$

$$99.47 \times 10^3 = 37.5 \times 8/2 \times \sigma_{ck} \times 25/2.$$

$\boxed{\sigma_{ck} = 53.05\ Mpa}$ < 60 Mpa given, The design is Safe

Design of flange:

Thickness of flange $= 0.5d = 0.5 \times 25 = 12.5\,mm.$
Outer ϕ of flange $D_2 = 4d = 4 \times 25 = 100\,MM.$

Check for Shear stress in flange:

$$T = \frac{\pi D^2}{2} \times t_f \times \tau_c \times D/2.$$

$$99.47 \times 10^3 = \frac{\pi \times 50^2}{2} \times 12.5 \times \tau_c.$$

$\boxed{\tau_c = 2.02}$ < 15 Mpa given & design is Safe.

Design for bolt

For ϕ 25 mm shaft,

No of bolt = 4. ; (P.S.G 7.107).

Pitch $\odot$le ϕ of bolt = 3d = 3x25 = 75 mm.

To find the size of bolt:

$$T = \pi/4 (d_1)^2 \times \tau_b \times n \times D_1/2.$$

$$99.47 \times 10^3 = \frac{\pi}{4} \times (d_1)^2 \times 33 \times 4 \times 75/2$$

$d_1^2 = 25.5$ mm.

$d_1 = 5.05$ mm $\simeq$ $d_1 = 6$ mm.

∴ The size of bolt is M6 is selected.

2. Design a shaft and flange for a Diesel Engine, in which protected type of flange Coupling is to be adopted for power Transmission. The following data is available for design. Power of Engine = 75 kw, Speed of Engine = 200 rpm. $\tau_{max\,s}$ = 40 Mpa. Max. permissible Twist in shaft = 1° in length of shaft equal to 30 times the diameter of shaft. T_{max} = 1.25 T_{mean}. pitch ⊙le ∅ of bolts = 3d. Max. stress in bolt = 20 Mpa.

Find : i) Diameter of shaft. ii) Number of bolts, iii) Dia of bolt.

Given:

Power (P) = 75 kw.
Speed (N) = 200 rpm.
Shear Stress for Shaft (τ_s) = 40 Mpa.
Angle of Twist θ = 1° = $\pi/180°$ = 0.0175 rad.
Length l = 30d.
T_{max} = 1.25 T_{mean}.
pitch ⊙le ∅ of bolt D_1 = 3d.
Shear Stress in bolt (τ_b) = 20 Mpa.

Design of Hub:

We know, $P = \frac{2\pi N T}{60}$.

$$T = \frac{P \times 60}{2\pi N} = \frac{75 \times 10^3 \times 60}{2 \times \pi \times 200}$$

T_{mean} = 3580.9 N.m. T_{max} = 4476.23 N m

Design of flange:

Thickness of flange $t_f = 0.5d = 50mm$.
Protective circumferential flange $t_p = 0.25d = 25mm$

Design of bolt:

For ϕ 100 mm. shaft.

No of bolts = 6.

Given pitch cle ϕ of bolt $D_1 = 3d = 300mm$.

To find the ϕ of bolt:

$$T = \frac{\pi}{4}(d_b)^2 \times \tau_b \times n \times D/2.$$

$$447.6.23 \times 10^3 = \frac{\pi}{4}(d_b)^2 \times 20 \times 6 \times \frac{300}{2}.$$

$$d_b^2 = 316.62.$$

$d_b =$ ~~18~~ $17.79mm$ Say $d_b = M18$.

∴ M18 bolt is selected

To find Diameter of shaft

$T = \frac{\pi}{16} \times \tau_s \times d^3 \rightarrow (NA).$

$\frac{T}{J} = \frac{C \times \theta}{l}.$

Assume $84\ kN/mm^2 = C$.

$$\frac{4476 \cdot 23 \times 10^3}{\frac{\pi}{32} \times d^4} = \frac{10^3 \times 84 \times 0.0175}{30d}.$$

$d = 97.6\ mm$ $\simeq 100\ mm = d$

Inner ϕ of Hub = ϕ of shaft = $d = 100\ mm$.
Outer ϕ of Hub = $D = 2d = 200\ mm$.
Length of Hub = $L = 1.5d = 150\ mm$.

Design of key:

For ϕ 100mm shaft, $W = 28\ mm$
$t = 16\ mm$.

Length of key = Length of Hub = 150mm.